

REMARKS**A. Period For Reply**

A shortened statutory period for reply was set to expire three months from the mailing date of the Office Action of January 15, 2004. This Amendment and Remarks is being filed on or before May 15, 2004 (with a petition for a one month extension of time).

B. Status

The Office Action of January 15, 2004 was nonfinal.

C. Disposition Of Claims

Claims 1-20 are pending.

D. Application Papers

At the appropriate time, approval of the formal drawings, submitted with the filing of this case on December 21, 2000, would be appreciated.

E. Priority under 35 U.S.C. §§ 119 and 120

Acknowledgement of the claim for foreign priority would be appreciated.

Receipt of the certified copy was acknowledged on page 2, lines 1-2 of the Office Action of January 15, 2004.

As to domestic priority, this case does not claim domestic priority.

F. Attachments

Applicant filed two PTO-1449 forms in this case (one with the filing of this case on December 21, 2000 and one on February 17, 2003). These PTO-1449 forms were signed and all of the references listed on the forms were initialed by the Patent Office. This is very much appreciated.

G. Basis for amendments to claims

Claim 1 has been amended as follows:

3 ≤ (furfural concentration by weight)/(acrolein concentration by weight) ≤ 100.

Basis for such amendment is found at 1) page 6, lines 1-19 where the concentration ratio of furfural to acrolein being 100 or below is taught, 2) in Example 1 where the concentration ratio of furfural to acrolein is 3, 3) in Example 3 where the concentration ratio of furfural to acrolein is 25, and 4) in Example 4 where the concentration ratio of furfural to acrolein is 75. Please see Table 1 on page 23 of the specification.

Claim 1 has further been amended to recite the phrase "prior to the crude acrylic acid being charged with said aldehyde treatment chemical."

Basis for such amendment is found in the specification from page 6, line 24 to page 8, line 2. Further basis is found on page 8, lines 18-25 of the specification.

Claim 2 has been amended as follows:

2 3 ≤ (furfural concentration by weight)/(acrolein concentration by weight) ≤ 30.

Basis for such amendment is found at 1) page 6, lines 6-19 where the concentration ratio of furfural to acrolein being between 2 and 30 (including the value 2 and 30) is taught, 2) in Example 1 where the concentration ratio of furfural to acrolein is 3, and 3) in Example 3 where the concentration ratio of furfural to acrolein is 25.

Dependent claims 9-12 have been added. These claims are identical, except for their respective dependencies (upon claims 5-8). Basis for new dependent claims 9-12 is found on 1) page 9, lines 17-23 of the specification and 2) in Example 6.

Independent claim 13 has been added. Basis for independent claim 13 is found at the following locations in the specification:

- ♦ Page 3, lines 8-11 where it is stated that "at a specific range of the concentration ratio of furfural to acrolein, efficiency of the aldehyde treatment chemical is improved;"
- ♦ Page 6, line 1 to page 8, line 2 where the "Basis of Purification" is discussed; and
- ♦ The specification as a whole, including the drawings.

Claims 14-20, dependent upon independent claim 13, have been added. Basis for claim 14 is original claim 1. Basis for claim 15 is original claim 2. Basis for claim 16 is found in the discussion above as to amended claim 1. Basis for claim 17 is found in the discussion above as to amended claim 2. Basis for claim 18 is original claims 3 and 4. Basis for claim 19 is original claims 5 and 6. Basis for claim 20 is found in the discussion above as to new claims 9-12.

H. The Office Action

H.1. Page 2 of the Office Action: receipt of papers

On page 2 of the Office Action, the Patent Office acknowledged the receipt of papers submitted under 35 U.S.C. 119(a)-(d) and further noted that such papers have been placed of record in the file. This acknowledgement is appreciated.

H.2. Pages 2-3 of the Office Action: basis for rejection of claims

On pages 2-3 of the Office Action, the Patent Office stated that claims 1-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bauer, Jr. et al. (5,759,358) in view of Fauconet et al. (6,352,619) and provides a discussion of such combination. This rejection and discussion is respectfully traversed on the grounds of applicant's discussion in section I of this paper below.

It should be noted that, on page 3 of the Office Action, the Patent Office states that Bauer, Jr. et al. differs from the claimed invention in that claim 1, for example, recites "...charged with an aldehyde treatment chemical." However, by "aldehyde treatment chemical," applicant means a chemical that treats aldehydes.

I. Applicant's discussion

I.1. The Bauer, Jr. et al. reference

In column 1, lines 23-24, the Bauer, Jr. et al. reference notes that crude acrylic acid contains aldehyde impurities such as acrolein and furfural.

In the paragraph bridging columns 2-3, the Bauer, Jr. et al. reference broadly describes its invention and states:

- 1) that its inventive process uses selected groups of amines at different points of the continuous process in providing in providing PGAA (pure grade acrylic acid);
- 2) in one embodiment, one or more amine from one selected group of amines (Group A) is added to CAA (crude acrylic acid) to provide a crude acrylic acid feed stream;
- 3) within the CAA feed stream, the Group A amine

rapidly reacts with acrolein and other "light" aldehydes (aldehydes boiling lower than AA), effectively removing them from volatilizing in the column;

- 4) the CAA feed stream is fed to a fractional distillation column and distilled; and
- 5) concurrently with the distillation of the CAA feed stream, an amine feed stream of one or more amines from another selected group of amines (Group B) is introduced at or near the top of the column to facilitate removal of any remaining residual volatile aldehydes, particularly furfural and maleic anhydride, and that the resulting distillate is PGAA.

In column 4, lines 37-60, the Bauer, Jr. et al. reference provides that Group S amines, which are substantially soluble in CAA, are effective in reducing acrolein before distillation, and that another group of amines, Group P amines, is added to the Group S-treated stream either immediately prior to distillation or to the upper portion of the distillation column to further reduce residual aldehydes, particularly furfural and benzaldehyde, during distillation.

In column 5, lines 31-40, the Bauer, Jr. et al. reference provides that CAA is dehydrated AA and typically contains the following aldehydes in their weight amounts indicated: for example, acrolein, ranging from several ppm to about 300 ppm; furfural, about 200-400 ppm. It should be noted that there is no disclosure here of adjusting the furfural to acrolein ratio prior to treatment of aldehydes with a chemical (such as an amine).

In the paragraph bridging columns 5-6, the Bauer, Jr.

et al. reference provides that the Group A amine is selected to react rapidly and substantially irreversibly with acrolein and other light aldehydes present in CAA or other AA sources preceding CAA and that most group A amines react in-line as to the CAA or other AA source are being led, with the amine, to a distillation column. However, this disclosure too does not suggest adjusting the furfural to acrolein ratio prior to treatment of aldehydes with a chemical (such as an amine).

In column 8, lines 11-17, the Bauer, Jr. et al. reference teaches that an advantage of these approaches using, for example, either aqueous sources of AA or high acetic acid-containing CAA, is that acrolein and other light aldehydes are removed early in the AA purification process, with the added benefit of reducing the tendency for the AA to polymerize while being purified, thus allowing a reduction in polymerization inhibitor level during further processing. "These" approaches use amines, an agent that chemically treats aldehydes.

In the Bauer, Jr. et al. reference, the paragraph bridging columns 8-9 relates to measuring acrolein content such as in an output from a distillation column or other unit to which the Group A amine-treated stream is fed. Hence, such a measurement occurs after the stream, be it AA or CAA, has been treated with an agent that chemically treats aldehydes.

In the Bauer, Jr. et al. reference, the paragraph in column 9, at lines 10-25 relates to measurement of furfural, albeit in the distillate of the final distillation column..

The Bauer, Jr. et al. reference provides Examples 1 and 2 and Comparative Examples 1-4 in columns 11 and 12. The starting furfural to acrolein ratios are summarized below:

Example 1: (240 ppm furfural)/(85 ppm acrolein) = 2.82
Example 2: (250 ppm furfural)/(91 ppm acrolein) = 2.75
Com. Ex. 1: (270 ppm furfural)/(66 ppm acrolein) = 4.09*
Com. Ex. 2: (240 ppm furfural)/(85 ppm acrolein) = 2.82
Com. Ex. 3: (250 ppm furfural)/(91 ppm acrolein) = 2.75
Com. Ex. 4: (270 ppm furfural)/(69 ppm acrolein) = 3.91*

*Comparative Example 1 does not add any chemical that treats aldehyde, contrary to independent claims 1 and 13.

*Comparative Example 4 feeds amine to the upper portion of the column alone, not to the pot, and hence does not teach the distillation of a crude acrylic acid charged with a chemical that treats aldehyde, which is a requirement of each of independent claims 1 and 13.

As to Examples 1 and 2, the ratios of Examples 1 and 2 are outside the claimed ranges of independent claim 1 and dependent claim 2. More to the point, however, is that it appears that these starting ratios of both the Examples and Comparative Examples are merely incidental.

As to Comparative Examples 1 and 4, it is respectfully submitted that these comparative examples teach away from applicant's invention. For example, as to Comparative Example 1, the Bauer, Jr. et al. reference notes that the levels of impurities in the distillate far exceed those required for PGAA. As to Comparative Example 4, the Bauer, Jr. et al. reference notes that the column suffered from heavy polymer shutdown and other solids formation. Further as to Comparative Example 4, the Bauer, Jr. et al. reference notes that feeding amine to the upper portion of the column alone was not satisfactory for PGAA production because of polymer and other solids formation in the column preventing continuous operation.

Moreover, Comparative Examples 1 and 4 of the Bauer, Jr. et al. reference do not teach what is claimed.

Comparative Example 1 does not add any chemical that treats aldehyde (i.e., CAA Distillation without Group A or B Amine Addition), whereas each of independent claims 1 and 13

requires the step of charging the crude acrylic acid with a chemical that treats aldehyde. Comparative Example 4 feeds mPD (m-phenylenediamine) to the upper portion of the column alone, not to the pot containing CAA, acrolein and furfural, whereas each of independent claims 1 and 13 requires distilling a crude acrylic acid containing acrolein, furfural, where the crude acrylic acid that is distilled is charged with a chemical that treats an aldehyde. Further, each of dependent claims 9, 10, 11, 12, and 20 requires the step of charging the crude acrylic acid with the hydrazine compound (a chemical that treats an aldehyde) prior to the step of distilling the crude acrylic acid.

In the Bauer, Jr. et al. reference, Tables 1, II, III, IV, V, VI and VII note "A" for acrolein and "F" for furfural. These tables, and their attendant examples, do not relate to a particular ratio of furfural to acrolein, or to adjusting such a ratio, prior to treating the spiked PGAA, CAA or aqueous acrylic acid solutions with an agent that chemically treats aldehydes.

The Bauer, Jr. et al. reference provides a furfural to acrolein ratio of 1/91 or 0.01 in Table VIII, a furfural to acrolein ratio of 193/77 or 2.51 in Table IX, and a furfural to acrolein ratio of 181/91 or 1.99 in Table X. Again, these ratios are outside the claimed ranges of independent claim 1 and dependent claim 2. And again, the more relevant point is that it appears that these starting ratios are merely incidental.

Tables XI and XII of the Bauer, Jr. et al. reference again denote "A" for acrolein and "F" for furfural and again measure the levels of acrolein and furfural only after treatment of the aldehydes, such as after thirty minutes and five days (Table XI) or after fifteen minutes or five hours (Table XII).

The claims of the Bauer, Jr. et al. reference begin after Table XII.

I.2. First ground for allowance

There are two independent claims in this case, claims 1 and 13. Independent claim 1 calls out the limitation of adjustment of the concentration ratio of furfural to acrolein prior to the crude acrylic acid being charged with said aldehyde treatment chemical. Independent claim 13 calls out the limitation of charging said crude acrylic acid with a chemical that treats aldehydes after determining whether the furfural to acrolein ratio is within or outside of a preset range and after adjusting the ratio to fall within the preset range. Such limitations are not taught by either of the Bauer, Jr. et al. or Fauconet et al. references or both references in combination. Allowance of independent claims 1 and 13 are respectfully requested on the basis of these first positively claimed grounds.

It should be noted that this first argument does not depend upon the specific range limitation called out in independent claim 1. No range limitation has been called out in independent claim 13.

The Bauer, Jr. et al. reference takes the furfural to acrolein ratio as given to it. In other words, the Bauer, Jr. et al. reference considers the furfural to acrolein ratio as incidental. The Bauer, Jr. et al. reference fails to manage the furfural to acrolein ratio prior to the step of aldehyde treatment.

Moreover, it should be noted that treatment of aldehydes in crude acrylic acid tends to promote polymerization, which is undesirable in a method for purification of acrylic acid. A hydrazine compound is an example of an aldehyde treatment chemical that is preferably

minimized in a stream of crude acrylic acid.

I.3. Second ground for allowance

The second ground for allowance is that, even if the Bauer, Jr. et al. reference teaches adjustment of the furfural to acrolein ratio prior to aldehyde treatment, which it does not, the incidental furfural to acrolein ratio of the Bauer, Jr. et al. reference does not fall into the claimed range of any of claim 1, dependent claim 2, dependent claim 16 or dependent claim 17.

It is believed that all of the furfural to acrolein ratios for the starting streams of the Bauer, Jr. et al. reference are identified below:

Example 1: $(240 \text{ ppm furfural}) / (85 \text{ ppm acrolein}) = 2.82$

Example 2: $(250 \text{ ppm furfural}) / (91 \text{ ppm acrolein}) = 2.75$

Com. Ex. 1: $(270 \text{ ppm furfural}) / (66 \text{ ppm acrolein}) = 4.09^*$

Com. Ex. 2: $(240 \text{ ppm furfural}) / (85 \text{ ppm acrolein}) = 2.82$

Com. Ex. 3: $(250 \text{ ppm furfural}) / (91 \text{ ppm acrolein}) = 2.75$

Com. Ex. 4: $(270 \text{ ppm furfural}) / (69 \text{ ppm acrolein}) = 3.91^*$

Table VIII: $(1 \text{ ppm furfural}) / (91 \text{ ppm acrolein}) = 0.01$

Table IX: $(193 \text{ ppm furfural}) / (77 \text{ ppm acrolein}) = 2.51$

Table X: $(181 \text{ ppm furfural}) / (91 \text{ ppm acrolein}) = 1.99$

*Comparative Example 1 does not add any chemical that treats aldehyde, contrary to independent claims 1 and 13.

*Comparative Example 4 feeds amine to the upper portion of the column alone, not to the pot, and hence does not teach the distillation of a crude acrylic acid charged with a chemical that treats aldehyde, which is a requirement of each of independent claims 1 and 13.

And again, as discussed above, it is respectively submitted that the Bauer, Jr. et al. reference teaches away from the claimed range by using comparative examples where the furfural to acrolein ratio falls into the claimed range. For example, as to Comparative Example 1, the Bauer, Jr. et al. reference notes that the levels of impurities in the

distillate far exceed those required for PGAA. As to Comparative Example 4, the Bauer, Jr. et al. reference notes that the column suffered from heavy polymer shutdown and other solids formation. Further as to Comparative Example 4, the Bauer, Jr. et al. reference notes that feeding amine to the upper portion of the column alone was not satisfactory for PGAA production because of polymer and other solids formation in the column preventing continuous operation.

Further as discussed above, Comparative Examples 1 and 4 of the Bauer, Jr. et al. reference do not teach what is claimed. Comparative Example 1 does not add any chemical that treats aldehyde (i.e., CAA Distillation without Group A or B Amine Addition), whereas each of independent claims 1 and 13 requires the step of charging the crude acrylic acid with a chemical that treats aldehyde. Comparative Example 4 feeds mPD (m-phenylenediamine) to the upper portion of the column alone, not to the pot containing CAA, acrolein and furfural, whereas each of independent claims 1 and 13 requires distilling a crude acrylic acid containing acrolein, furfural, where the crude acrylic acid that is distilled is charged with a chemical that treats an aldehyde. Further, each of dependent claims 9, 10, 11, 12, and 20 requires the step of charging the crude acrylic acid with the hydrazine compound (a chemical that treats an aldehyde) prior to the step of distilling the crude acrylic acid.

Since the only examples that cite values falling into the claimed range are comparative examples that 1) teach away from the invention and that 2) fail to teach other requirements of independent claim 1, allowance of independent claim 1 and its dependent claims are respectfully requested on the basis of this second

positively claimed ground.

I.4. Advantages of the positively claimed limitations

Please see page 6, lines 11-19 of the present specification where advantages of the furfural to acrolein concentration are set out. Namely, by keeping the concentration ratio of furfural to acrolein within the noted range, efficiency of the aldehyde treatment operation is improved, which in turn enables an efficient elimination of impurities upon distillation. Further, when efficiency of the aldehyde treatment is improved, the amount of the chemical used to treat aldehydes may be decreased, which in turn decreases the chance of polymer formation.

For example, as to an efficient elimination of impurities upon distillation, please compare Examples 1 and 3 with Example 2 of Table 1 on page 23 of the present specification. The ratios of the concentration of furfural to the concentration of acrolein in Examples 1 and 3 are 3 and 25, respectively, and such ratios result in distillate ppm concentrations of furfural and acrolein of not more than 0.5 and not more than 0.5, respectively. On the other hand, the ratio of the concentration of furfural to the concentration of acrolein in Example 2 is 1.5, and such a ratio results in distillate ppm concentrations of furfural and acrolein of 0.9 and 0.9, respectively.

I.5. Discussion of dependent claims 9-12 and 20 as to the residual limitation

As indicated above in section I.4., adjustment of the furfural to acrolein ratio improves the efficiency of the aldehyde treatment operation, which in turn requires a lesser amount of the chemical used for the aldehyde treatment operation. The residual of such lesser amount of

chemical (where the residual is that amount of chemical after aldehyde treatment and prior to the step of distilling of the crude acrylic acid) is positively recited in dependent claims 9-12 and 20 as not more than 100 ppm.

Please compare Examples 5 and 6. In Example 5, a residual hydrazine concentration was 150 ppm and after two months of operation 10 kg of acrylic acid polymer was found in the column. In Example 6, a residual hydrazine concentration was 50 ppm and after two months of operation 3 kg of acrylic acid polymer was found in the column.

As to claims 9-12 and 20, the undersigned cannot find any disclosure in the Bauer, Jr. et al. reference that measures, or teaches the measurement of, a residual hydrazine compound after aldehyde treatment and prior to distilling.

I.6. Discussion of dependent claims 9-12 and 20 as to the "prior to the step of distilling" limitation

Each of dependent claims 9-12 and 20 includes, beyond the "residual" limitation, the limitation of "charging the crude acrylic acid with the hydrazine compound prior to the step of distilling the crude acrylic acid." This limitation makes explicit that which is implicit in independent claims 1 and 13 to make it clear that Comparative Example 4 of the Bauer, Jr. et al. reference does not read upon the claims, especially dependent claims 9-12 and 20.

J. Summary

It is respectfully submitted that the Bauer, Jr. et al. reference does not teach the timing, spelled out in independent claims 1 and 13, of the adjustment of the furfural to acrolein concentration. The claimed time is prior to treatment of the crude acrylic acid with a chemical

that treats aldehydes, such as an amine taught by the Bauer, Jr. et al. reference. The Fauconet et al. reference does not cure this deficiency. Hence allowance of claims 1-20 is respectfully requested.

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